TITLE OF THE INVENTION

Method and Apparatus for a Molded Tube and Peristaltic Pump.

TECHNICAL FIELD OF THE INVENTION

This invention relates generally to pumping systems, and more particularly to peristaltic pumping systems.

BACKGROUND OF THE INVENTION

Peristaltic pumps are widely used in various applications, including applications in the beverage and pharmaceutical fields, among other fields. Peristaltic pumps generally operate by compressing a flexible tube or channel with one or more heads (or other mechanisms). The head or heads pinch off a portion of the tube or channel (against either a back or an opposing head) and push fluid in the desired direction.

In some applications, a peristaltic pump itself is used over and over again and the tube is frequently replaced, such as when a beverage concentrate is depleted in a beverage system or a medicine is depleted in a pharmaceutical application. In other applications, one tube may be used with the same pump for a relatively long time. In still other applications, the pump itself may be disposable along with the tube.

Although peristaltic pumps offer certain advantages, they do not economically allow for the kind of reproducible and precise flow rates that are often required. In many instances, the inaccuracies result from the tubes, which are made with an extrusion process. The extrusion process results in variations in the inside diameters of the tubes, as well as variations in the thickness of the tube walls. Because of such variations, as tubes are replaced, different flow

rates result from the same pump. Also, variations occur from pump to pump (and thus system to system), because of the differences in the tubes, both in disposable tube applications, and in applications where one tube is used for a relatively long time. It is generally not practical to calibrate systems to overcome the variations.

Thus, for example, where a beverage concentrate is to be pumped at a specific flow rate for mixture with water at a given ratio, tube variations result in inaccurate mixture ratios – and hence different quality drinks – from tube to tube. Such beverage systems are often used in restaurants and convenience stores (among other locations), and the variations create unacceptable differences in drink quality from batch to batch in the same location, and from location to location. Similar issues are found in other applications, such as those in the pharmaceutical field.

Another problem with prior art peristaltic pumps is that the pump inlet side of the tube is often attached to a tube fitment that operates as a restriction to free flow to the inlet to the pump.

Therefore, a need has arisen for peristaltic pump and tube system that overcomes the limitations of prior art systems.

SUMMARY OF THE INVENTION

In accordance with the teachings of the present invention, methods and apparatus for a molded tube and peristaltic pump are provided which eliminate or substantially reduce the problems associated with prior art systems.

In a particular embodiment, a pump for pumping a material is provided which includes a motor, a molded tube, and one or more compression heads coupled to the motor and adapted to compress the molded tube for pushing the material in a desired flow direction. In one

embodiment, the molded tube comprises a first section having a first inside diameter, and a second section having a second inside diameter greater than the first inside diameter. In another embodiment, a fitment is coupled to the second section. Also, the discharge end of the tube may have an inside diameter greater or less than other parts of the molded tube. The molded tube may be an injection molded tube.

In another embodiment of the present invention, a fluid delivery system is provided which includes a peristaltic pump, a molded tube coupled to the peristaltic pump through which the fluid flows, a supply of the fluid coupled to the molded tube upstream of the peristaltic pump, and a dispenser coupled to the molded tube downstream of the peristaltic pump. In one embodiment, the molded tube comprises a first section having a first inside diameter, and a second section having a second inside diameter greater than the first inside diameter. In another embodiment, a fitment is coupled to the second section. Also, the discharge end of the tube may have an inside diameter greater or less than other parts of the molded tube. The molded tube may be an injection molded tube.

Particular applications for the present invention include, without limitation, beverage and pharmaceutical applications.

Also provided is a method of forming a molded tube for a peristaltic pump, which includes providing a core and a fitment, providing a cavity adapted to mate with the core and fitment, injecting material into the cavity for forming the molded tube around at least a part of the core and fitment, and ejecting the molded tube and fitment from the core.

In a particular embodiment, the injected material is a thermosetting elastomer. In one embodiment, the molded tube and fitment are ejected by supplying a gas through the core. In another embodiment, the fitment is formed and then placed on the core. In an alternative

embodiment, the fitment is molded in place on the core. In another embodiment, a weakened area may be formed on the molded tube for removing an end of the tube, and, if desired, a removal tab may be formed proximate to the weakened area.

In another embodiment, the fitment has a fitment inside diameter, and the fitment inside diameter is greater than or equal to an inside diameter of a portion of the molded tube not formed around the fitment. In still another embodiment, the molded tube has a discharge end with an inside diameter different than a portion of the molded tube not formed around the fitment.

One important technical advantage of the present invention is that it includes a molded tube which allows more precise and repeatable flow rates from peristaltic pumping systems than prior art systems. Another important technical advantage of one embodiment of the present invention is that it includes a molded tube which may be formed in combination with a fitment. Still another important technical advantage of the present invention is that it includes a molded tube which may be formed with an increased diameter portion which makes it easier to improve flow rates into peristaltic pumping systems.

BRIEF DESCRIPTION OF THE DRAWINGS

Reference is made in the description to the following briefly described drawings, wherein like reference numerals refer to corresponding elements:

FIGURE 1 is a block diagram of one embodiment of a peristaltic pump and tube according to the teachings of the present invention;

FIGURE 2 illustrates one embodiment of a tube for a peristaltic pump according to the teachings of the present invention;

FIGURE 3 is an isometric view of one embodiment of a mold for making a tube according to the teachings of the present invention;

FIGURE 4 illustrates another embodiment of a tube for a peristaltic pump according to the teachings of the present invention;

FIGURE 5 is a cross sectional view of one embodiment of a molding system for making a combined fitment and molded tube according to the teachings of the present invention; and

FIGURE 6 is a cross sectional view of the molding system of FIGURE 5 in the open position.

DETAILED DESCRIPTION OF THE INVENTION

As shown in FIGURE 1, a peristaltic pump 10 is shown in block form, which includes a motor 12, a shaft 14, and head (or heads) 16. Head or heads 16 engage a molded tube 18.

The head or heads 16 squeeze the tube 18 (against a back or opposing head or heads) and push fluid in the desired direction. In the particular example illustrated in FIGURE 1, the fluid comes from a supply 20, which may be a bag of fluid, such as a plastic bag used in a bag-in-box beverage system, or a pharmaceutical bag, used for pharmaceuticals or other fluids. The supply 20 generally includes a supply fitment 22 that is coupled to a tube fitment 24 through any of several known approaches. The tube fitment 24 may be coupled to the tube 18 through any of several known approaches, or as described below as part of the molding process. Downstream of the pump 10, the tube 18 is coupled to dispenser 26. Dispenser 26 may be, for example and without limitation, a beverage dispenser or a needle for an injection into a patient, or any other dispensing device, and may also be simply the open end of the tube 18. It should also be understood that the tube 18 or tube fitment 24 may be coupled directly to the supply 20 (or to the

supply fitment 22) and to the dispenser 26, or through any number of intermediate coupling devices. Of course, the pump may be integrated with the dispenser or the supply.

Although a peristaltic pump with a motor, shaft, and head is illustrated, any peristaltic pump mechanism may be used, including, without limitation, those that squeeze a tube and move fluid in the tube with one or more roller heads, sliding heads, caterpillar mechanisms, wave mechanisms, cams, disks, or other devices. Examples of particular peristaltic pumps are described in US Patent Nos. 5,413,252 and 5,558,507, which are herein incorporated by reference in their entirety. The incorporation of these examples is illustrative only, and not by way of limitation, and thus is not meant to limit the scope of the invention or to exclude from coverage any other type of peristaltic pump mechanism. For ease in describing any of the various peristaltic pump mechanisms, the squeezing mechanism may be referred to herein as a compression head. Also, although the supply 20 is illustrated as a flexible bag, any source may be used.

The tube 18 of the present invention is molded, and is not extruded as are prior art tubes. In a particular embodiment, the molding process is an injection molding process. Because the molding process allows for very precise tolerances, the kinds of variations found in prior art tubes are substantially or completely eliminated with the molded tube of the present invention. It should be understood that any other suitable molding process may also be used, including, without limitation, compression molding.

FIGURE 2 illustrates a particular tube 18, in combination with a tube fitment 24, before being used in a dispensing system such as that shown in FIGURE 1. In the particular embodiment shown in FIGURE 2, the tube 18 includes an end 30 and an expanded diameter section 32. The end 30 is a sealed (or otherwise closed) end of the tube 18, and ensures that the

tube 18 remains clean before use (at which time the end 30 is removed). It should be understood that the end does not have to be sealed.

The expanded diameter section 32, although not necessary in all embodiments of the present invention, provides a significant advantage over prior art tubes. In particular, by forming the expanded diameter section 32 with an inside diameter greater than that of the main portion of tube 18, the tube fitment 24 (or supply fitment if the tube is coupled directly to the supply) may have an inside diameter equal to or greater than that of the main portion of tube 18, and can be easily coupled to the tube 18 (the tube may also be formed on the fitment, as described below). With such a fitment, flow to the pump inlet side of the tube is not restricted (as the diameter is not diminished), and thus the peristaltic pump is not "starved" and its performance limited thereby. In some prior art systems, tube fitments cause inlet pump flow restrictions, as it is difficult to stretch an extruded tube over a wide tube fitment. The flow restriction issue is particularly important in pumping relatively high viscosity liquids, such as, without limitation, orange juice concentrate, wherein inlet flow restrictions can significantly affect desired flow rates.

The expanded diameter section 32 may be formed in other processes as well, such as, without limitation, with an expansion mandrel inserted into the tube 18. Furthermore, the expanded diameter section may be formed with features, such as, without limitation, shoulders, grooves, or lips, to accommodate the tube fitment 24 (or supply fitment) and enhance the fit between them. However, it should be understood that any approach may be used to couple the tube with a fitment.

FIGURE 3 is an exploded view of one embodiment of a molding system for forming a molded tube 18 according to the teachings of the present invention. As shown in FIGURE 3, a

male plug (or core) 40 is formed on a base 42. A cavity block 44 having a cavity 46 mates with the core 40. Injection material, such as, without limitation, an injection-moldable grade of a thermosetting elastomer, for example "liquid silicone" rubber, is injected into the cavity 46 and cured around the core 40 to form the molded tube 18 shown in FIGURE 3. It should be understood that other injection materials, such as, without limitation, a thermoplastic elastomer, may also be used.

The particular core shown in FIGURE 3 includes a base 48 for forming expanded diameter section 32. It should be understood, however, that, although desirable, no such base or expanded diameter section is required as part of the present invention. As discussed above, it is also desirable that the top of the tube 18 be closed, and thus the tube 18 is shown with a sealed end 30 (which may or may not have the same diameter as that of the main section of the tube). However, it should be understood that no such sealing is required as part of the present invention. Also, it should be understood that the end of the molded tube 18 opposite the section 32 (the discharge end) may be molded to form any shape desirable for coupling with downstream devices, and thus may have an expanded or reduced diameter. In some applications, for example, without limitation, those with high flow rates or relatively large diameter tubes, dripping is reduced by forming the discharge end with an inside diameter less than that of the main portion of tube 18.

As shown in FIGURE 4, the tube 18 may be (but need not be) formed with a weakened area 50 to facilitate easy removal of the end 30. Also, a removal tab 52 may be formed proximate to the weakened area 50 to allow a user to tear away the end 30 before use of the tube.

The tube 18 may be ejected from the mold system by any suitable approach. One approach, without limitation, is to inject a gas through a gas port 54, which allows gas (such as, without limitation, air) to flow through the end of the core 40 to eject the molded tube 18.

FIGUREs 5 and 6 are cross sectional views of another embodiment of a system for molding a tube 18 according to the teachings of present invention. In the particular embodiment shown in FIGUREs 5 and 6, the tube 18 is molded around a fitment 24. FIGURE 5 shows the molding system in the closed position, and FIGURE 6 illustrates it in the open position, with the tube 18 ready to be ejected. The fitment 24 may be of any suitable material, including, without limitation, plastic or metal. The fitment 24 may be formed in another process and inserted into the mold before it is closed, or molded in place in a shuttle mold system that allows for the injection of the fitment material and for injection of the tube material. If desired, although not required, the materials may be chosen so that they chemically bond to one another. With the embodiment of FIGUREs 5 and 6, a combined tube and fitment are produced, and no additional step of coupling a tube fitment with the tube is necessary.

An air injection pin 56 is fully inserted during the injection process, to prevent the injection material 58 from entering an ejection channel 60. Ejection channel 60 runs from the end of the core 40 to the gas port 54. When the air injection pin 56 is retracted, as shown in FIGURE 6, the channel 60 is opened and gas may be blown into the port 54 and through the core 40, to eject the tube 18 from the mold. The mechanism shown form ejecting the tube may also be used with the embodiment shown in FIGURE 3.

The particular embodiments and descriptions provided herein are illustrative examples only, and features and advantages of each example may be interchanged with, or added to the features and advantages in the other embodiments and examples herein. Moreover, as examples,

they are not meant to limit the scope of the present invention to any particular described detail, and the scope of the invention is meant to be broader than any example. For example, and without limitation, although beverage and pharmaceutical applications have been illustrated, the present invention may be used with any other fluid delivery system. And, in general, although the present invention has been described in detail, it should be understood that various changes, alterations, substitutions, additions and modifications can be made without departing from the intended scope of the invention, as defined in the following claims.